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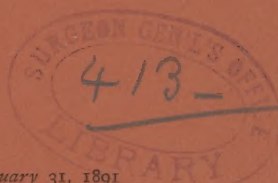
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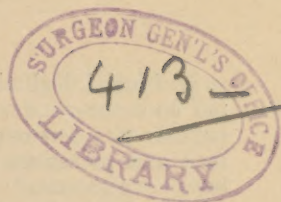
FREDERICK PETERSON, M.D.

ATTENDING PHYSICIAN TO THE NEW YORK HOSPITAL FOR NERVOUS DISEASES



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A Farther Study of Anodal Diffusion as a Therapeutic Agent.¹

BY FREDERICK PETERSON, M.D.,

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IN a paper read before the Section on Theory and Practice of the New York Academy of Medicine, in February, 1889, I called attention to the therapeutic value of the cataphoretic power of electricity, to which power I gave the name anodal diffusion.² The ability of a galvanic current, in flowing from the positive to the negative pole, to seemingly carry substances with it even through a membrane, or through the skin, has been affirmed by some, but even to this day, denied by other authorities.

Dr. B. W. Richardson first drew attention to what he termed voltaic narcotism in two articles in the *Medical Times and Gazette*, in 1859. He produced local anæsthesia with solutions of morphia, aconite, and chloroform, but the storm of opposition aroused over Europe made him subsequently abandon what was an actual discovery.

¹ Read before the Northwestern Medical and Surgical Society of New York, December 17, 1890.

² New York Medical Journal, April 27, 1889.

H. Munk killed rabbits by placing a solution of strychnia upon the anode, and applying it to the skin of the animals for a few minutes with moderate currents. Quinine and potassium iodide had also, many years ago, been experimentally introduced by cataphoresis, and quickly detected in the urine.¹

Nothing further was published until 1886, when Wagner² printed a short note expressing a belief that anæsthesia might be produced by the use of cocaine on the anode. He made no experiments.

In the same year Adamkiewicz³ introduced his diffusion electrode and described his experiments and successes with chloroform in the production of anæsthesia and the relief of pain.

The conclusions of Adamkiewicz were attacked by Paschkis and Wagner,⁴ who claimed that the contact of the chloroform with the skin was sufficient to produce the anæsthesia, and that the galvanic current had nothing to do with it for the resistance of chloroform was so great that it could not conduct at all.

Lumbroso and Matteini⁵ employed chloroform the same year with ordinary electrodes for the relief of neuralgia.

Dr. Corning,⁶ of this city, produced anæsthesia with a five per cent. solution of cocaine on the anode after pricking the skin with needles. This was also in 1886.

Dr. Reynolds,⁷ of Chicago, published, in 1887, an article upon the use of cocaine in two to twenty per cent-solutions with the anode in his dermatological practice for small cutaneous operations and for the electrolysis of hair roots. He also used voltaic narcotism in one case

¹ Landois and Sterling's Physiology, page 489.

² Wien. Med. Presse, 1886, page 212.

³ Neurolog. Centralb., vol. v., pp. 219-497.

⁴ Ibid., vol. v., page 413.

⁵ Sulla cataforesi elettrica. La riforma medica, July and November, 1886.

⁶ New York Medical Journal, November 6, 1886.

⁷ Journal of the American Medical Association, August 20, 1887.

of tooth-extraction, as had been done by Richardson just thirty years before. Owing to the publication of Dr. Reynolds's paper in the journal mentioned, it escaped my notice altogether, and was not included in the list of authorities given in my first paper. I am under obligation to Dr. R. H. M. Dawbarn for kindly calling my attention to it. Although Wagner and Corning had separately written about cocaine cataphoresis before Reynolds, they had not given it as great practical application as the latter.

When I took up the subject of anodal diffusion in the winter of 1888 and 1889, the bulk of information at my command was limited and uncertain. There was so much controversy on every point, so much diversity of opinion, that even the existence of the cataphoretic power of electricity seemed to be as yet not scientifically proven. I therefore made some hundred experiments upon myself and patients, the most important of which were detailed in my first paper already referred to.

The results of previous experiments may be summed up as follows :

The current alone does not produce anæsthesia at either pole, although the anode has a transitory soothing effect over painful foci.

A watery solution of cocaine applied to the skin is not absorbed, does not produce anæsthesia, except, perhaps, after an indefinitely long period. The same is true of chloroform and of an alcoholic solution of aconitia.

A watery solution of cocaine is diffused through the skin and subcutaneous tissues by the anode, but not by the cathode. This is true of chloroform, aconit'a, strychnia, potassium iodide, corrosive sublimate, tincture of iodine, and other medicaments.

The anæsthesia produced by a ten to twenty per cent. solution of cocaine on the anode is sufficient for small operations and affords distinct relief for from four to eleven hours in cases of severe neuralgias in superficial nerves and without constitutional effects.

The Adamkiewicz electrode is absolutely worthless, since it is so stupidly constructed that the current does not pass through the fluid contained within it but through its circular metallic rim.

Chloroform, recommended by Adamkiewicz, and by Lumbroso, and Matteini, should only be used for cataphoretic purposes when, in addition to producing a local anæsthesia it is desired to counter-irritate, for it causes a disagreeable dermatitis of a week's duration, as I have had reason to learn by experiment upon myself. It does induce a deep analgesia beneath the anode, but it also vesicates.

Up to February, 1889, I had employed anodal diffusion of solutions of cocaine and aconitia, separately or mingled, in two severe cases of chronic supra-orbital neuralgia, selected for me as crucial tests by Dr. Seguin; in one case of double trigeminal neuralgia; in one case of inferior maxillary neuralgia; in one case of locomotor ataxia for the relief of dorsal neuralgic pains. The success of the measure in all of these cases was undisputed. It gave hours of relief from excruciating pain, and without constitutional effects of any kind. Nothing was claimed for it as a curative procedure, but it certainly proved to be a more than efficient substitute in these cases for morphine, which, as we too well know, is so prone to exact for its hours of solace lifetimes of wreck and ruin.

Since the publication of my paper other articles which serve to show the growing recognition of the value of the method have emanated from various sources. Dr. Cagney,¹ of London, reported his experience in the use of cataphoresis before the Harveian Society, November 7, 1889. He employed iodine and a saturated solution of potassium iodide with the anode for labyrinthine deafness, lead palsy, small tumors of the skin and mucous membranes; for syphilitic and other throat affec-

¹ British Medical Journal, November 16, 1889.

tions; for chronic pharyngitis; for nodes and gummata, tubercular ulcers, mucous patches and papular syphilides; for indolent ulcers, lupus, acute and strumous glands. In the discussion upon Dr. Cagney's paper, Mr. Juler stated that he had found the method useful in tobacco amblyopia.

In the same month, Drs. Gärtner and Ehrmann¹ made a communication to the Imperial-Royal Society of Physicians, of Vienna, in reference to the cataphoretic use of corrosive sublimate. Dr. Gärtner's electric bath-tub was employed, from four to six grammes of mercuric bichloride being dissolved in the water of the bath. A current strength of 100 milliampères was passed through the person experimented upon for fifteen or twenty minutes, and subsequently mercury was found in the urine in as large a quantity as 1.3 milligr. There were traces of the metal in the urine for from four to six days after the bath.

Some time ago Boccolari and Manzieri² announced their intention to study the effects of electric cataphoresis in connection with mineral baths, but I have been able to find no published record of the results of their studies in this direction. They have published, however, their use of anodal diffusion of drugs in parasitic affections of hair roots.

Woodbury³ described in May, 1890, his successful employment of the anode with a solution of iodide of lithium in a case with a syphilitic cutaneous neoplasm.

Shoemaker⁴ has also written upon the uses of cataphoresis in certain skin diseases.

Dr. A. Barth⁵ describes cocaine cataphoresis as employed by him in a number of operations upon the tympanum and external auditory meatus, finding a ten per

¹ Wiener Med. Blätter, November 28, 1889.

² Internat. Klin. Rundschau, September 2, 1888.

³ Philadelphia Medical News, June 21, 1890.

⁴ Sajous' Annual, 1890.

⁵ New York Archives of Otology, April-July, 1890, New York, pp. 100-101.

cent. solution on cotton connected with the anode very successful.

At the International Congress held at Berlin in August, 1890, Dr. Bayles, of Orange, N. J., read a communication from Mr. Edison, the inventor, upon the medical employment of cataphoresis. The transactions of the Congress not yet having been published, I am indebted to my friend, Mr. A. E. Kennelly, Chief Electrician of the Edison Laboratory, for the following brief synopsis of Mr. Edison's experiments :

"The first trials were purely physical. With a current of twenty milliampères, lithium chloride was forced through a septum of animal membrane by electrical endosmose.

"The second series of trials was upon the person of a healthy young laborer, who dipped one hand in a solution of common salt, and the other in a five per cent. solution of lithium chloride in water, for two hours daily for ten days. His urine examined before the test showed no more than mere traces of lithium. His urine collected during that period exhibited distinct presence of lithium—five milliampères.

"The third trial was upon the person of an old man suffering from acute and chronic uric-acid concretions. He was in an advanced stage of the ailment, and most of his joints were affected ; the joints between the phalanges were almost obliterated. He immersed one hand in lithium chloride solution, the other in common salt solution, while a current from the one hundred and twenty volt electric-light circuit was employed through resistance to pass through his body. Measurements of the hand in the lithium chloride solution showed after some twenty-five hours of total application, a distinct reduction of bulk. There was also considerable relief from pain, and the general condition of the patient was ameliorated. The current strength in his case was twenty milliampères (four times more than the previous healthy subject could stand with convenience)."

Mr. Kennelly also calls my attention to a pretty experiment recently described by Dr. Ehrmann to demonstrate the cataphoretic power of the anode :

Take two similar glass vessels, with zinc electrodes at the bottom, and filled with a very weak solution of methyl blue. Insert the hands, one in each, and cause ten to twenty milliamperes to pass for five to ten minutes. The hand in the anode vessel will be covered with blue spots.

The earlier criticisms of medical men that there was no such thing as the anodal diffusion of drugs must in the face of such accumulating evidence be entirely silenced. It is only one and a half years ago since, in the discussion of my paper, some who took part manifested entire incredulity. The far more vital criticism, however, that accuracy of dosage was impossible by this method of medication has been until now unanswered. The hollow electrode of Munk with clay bottom, of Adamkiewicz with carbon bottom, and of myself with a membranous bottom, each has failed to determine properly the quantity of the medicament employed. But this is now no longer a valid argument against anodal diffusion, since by the means I have of late employed, exact dosage is simplicity itself.¹ It is only essential to possess a flat metal electrode, preferably but not necessarily of platinum (platinum is now almost as costly as gold) or tin. A nickel plated surface will answer. This may be made of any size, round or square, convex or concave. A piece of tissue or filtering paper or linen is cut to fit over the metal surface. Upon it is placed, drop by drop, the solution of any drug to be used, and the electrode is then applied to the skin. There is then a thin capillary layer of the medicament in the paper disk between the electrode and the skin, and the quantity of the drug is known. The electrode made for me by Messrs. White & Bartlett, of this city, is round, flat, two or three centimetres in diameter, and is provided with a narrow, soft rubber rim at its edge,

¹ New York Medical Journal, November 15, 1890.

which, by its close approximation to the skin, prevents any loss of the solution by evaporation. In order to have drugs ready for use at any time, disks of paper to fit the electrode may be charged with aqueous or alcoholic solutions, and then allowed to dry, a drop or two of menstruum being added when they are to be used. Otto Boeddiker, Pharmacist, 954 Sixth Avenue, of this city, is prepared to furnish anyone with medicated cataphoretic disks to fit the electrode, and has made for me satisfactory disks of menthol, cocaine, helleborin, strychnine, iodol, corrosive sublimate, aconitine, potassium iodide, imido-succinate of mercury, and the chloride and benzoate of lithium.

As regards the current strength to be employed one must be guided by the patient's feelings. Anywhere from five to twenty milliamperes may be used for from five to fifteen minutes. The stronger the current the shorter the duration of the *séance*. If one has no galvanometer he may use ten to thirty or more cells of any battery, Grenet, Lèclanchè, or chloride of silver.

Anodal Diffusion of Drugs.—The indications for the application of the method of anodal diffusion of drugs may be summarized as follows :

To Produce Local Anæsthesia for Neuralgias, Superficial Pains, and Cutaneous Operations.—With an additional experience of nearly two years in the frequent treatment of neuralgias of superficial nerves with ten to twenty per cent. solution of cocaine on the anode, I can only reiterate my conviction that it is the best means we have for relief of the pain without constitutional effects. I have had no experience of the method in surgery, but I quote the following from a letter received from Dr. R. H. M. Dawbarn, June 10, 1889, which will merely serve as an instance of the successful employment of voltaic narcotism in a small operation :

“I have recently, since reading your article, tried this method upon a child's hand, requiring suture of a severed tendon. The injury was an old one, and there was no

wound before I made my incision. The anæsthesia from ten per cent. cocaine upon the anode, continued with my chloride of silver battery (twelve cells) for ten minutes, was very satisfactory."

I have experimented with other local anæsthetics. Aconitia produces a deep analgesia, but it is accompanied with severe smarting around the edges of the anæsthetized area. A combination of cocaine with the aconitia prevents this hyperæsthesia. I was led by a note on helleborin ¹ in a medical journal to make use of this alkaloid as a local anæsthetic. Three or four drops of a one per cent. solution of helleborin on the anode have brought about much more gratifying results than cocaine, a deeper and more lasting anæsthesia, and I have never noted constitutional effects. The latter need not be feared now that dosage has become accurate. At the same time I should advise caution in the employment of so powerful an alkaloid.

Both onabain and strophanthin ² (Arnaud's, not Merck's) are strong local anæsthetics, and may be used with the anode in doses of $\frac{1}{250}$ of a grain or more. One or two drops of chloroform on a tissue-paper disk placed upon the anode will bring about a deep analgesia in a very short time, but will be followed later by vesication. When it is desirable to first anæsthetize and then counter-irritate, chloroform cataphoresis may be advisable, and will prove useful in some neuralgias.

A mild solution of carbolic acid may also be employed as a local anæsthetic and analgesic.

For Topical Medication in various Local Lesions, such as Tumors, Rheumatic, Gouty, and other Swellings, various Skin Diseases, Syphilides, etc.—For such cutaneous disorders as are commonly treated by painting with iodine, the use of some of the iodine preparations, such as potassium, sodium, or lithium iodide, iodol, or diluted tincture of iodine upon the anode is indicated.

¹ Venturini and Gasparini. Brit. Med. Journ., August 4, 1888.

² Fortschritte der Medicin, February 1, 1890.

For rheumatic and gouty swellings, solutions of the chloride, benzoate, or citrate of lithium, all very soluble salts, should be employed with the anode. Among mercurial remedies the imidosuccinate and bichloride of mercury are well adapted for cataphoretic purposes.

The rhinologist and laryngologist will find the method particularly adapted to the treatment of many difficulties of the upper air-passages which may require the application of anæsthetics, astringents, or antiseptics.

For Electro cataphoretic Baths for General Purposes.—There would seem to be considerable usefulness in the method as applied to mineral baths. Although Gärtner has been at great pains to invent a particular kind of bath-tub with two compartments for electrical purposes, it is not essential to have any such arrangement. By making an ordinary bath the anode, the hands may close the circuit by grasping a cathode suspended just above the bath. Thus almost the whole surface of the body may be subjected to the anodal diffusion of the therapeutic agent dissolved in the bath. Outside of tonic, stimulating, and alterative, such as are found in health resorts, cataphoretic baths of iodide of potash might prove useful in cases of lead poisoning, etc.

The Use of Cataphoresis for Diagnostic Purposes.—In the discussion which followed the reading of my first paper upon this subject, Dr. Starr called attention to the possible usefulness of cocaine cataphoresis in diagnosis. Thus if a pain were complained of, for instance in some part of the trigeminus, it should disappear under this treatment. If it did not, the lesion could be localized further back, or it might lead to the conclusion that it was a hysterical pain. I had myself an interesting example of its usefulness for this purpose some time ago. I was called in consultation to see a lady who had been suffering for months with a rather superficial but excruciating pain in the knee following slight trauma. The knee was swollen from blistering, the limb was rigid, the patient sleepless from pain and anxious to have the leg amputated. The

spot upon which I placed the anode with cocaine was so hyperæsthetic that the slightest touch made her wince with pain. Her eyes being closed, I stuck a pin in the part after a few minutes, which she did not notice. When she opened her eyes, the electrode having been removed, I touched the anæsthetic part with my finger, and she winced with pain the same as before. Although the limb was, I believe, subsequently amputated, my diagnosis of a hysterical knee-joint was amply corroborated by microscopical examination.

In view of all the facts which I have adduced in this brief paper, there can be no doubt that the anodal diffusion of drugs is destined to far wider application than it has as yet enjoyed, and that the general practitioner and the specialist alike will find the procedure increasingly useful as a practical therapeutic measure. To close with a quotation from an editorial in the *New York Medical Journal*, December 28, 1889, it is a method that "opens a way not otherwise attainable for influencing tissue metabolism and for changing morbid nutritive processes by sending the drugs into direct and immediate contact with diseased parts through a force which in itself must greatly enhance their active medicinal properties."

